

## **CLAIMS**

### **We claim:**

1. A semiconductor package comprising:  
5                   a packaging substrate;  
                    a semiconductor die mounted with the substrate;  
                    a heatspreader; and  
                    a multi-layer heat transfer element arranged between the  
semiconductor die and the heat spreader to enable thermal communication  
10                  between the die and the heat spreader.
2. The package of Claim 1 wherein the multi-layer heat transfer element  
includes:  
                    a core spacer element having a top surface and a bottom surface;  
15                  a first layer of thermally conductive reflowable material formed on the top  
surface; and  
                    a second layer of thermally conductive reflowable material formed on the  
bottom surface.
- 20   3. The package of Claim 2 wherein the die is attached to the second layer by  
a reflow process and wherein the heat spreader is attached to the first layer by the  
reflow process.
- 25   4. The package of Claim 2 wherein the core spacer element is comprised of  
conducting materials.
5. The package of Claim 2 wherein the core spacer element is comprised of  
metal.
- 30   6. The package of Claim 2 wherein the core spacer element is comprised of  
layers of metal.

7. The package of Claim 2 wherein the core spacer element includes vias that penetrate through the core spacer element.
8. The package of Claim 2 wherein the core spacer element includes dimples  
5 formed therein.
9. The package of Claim 2 wherein the core spacer element is comprised of a conducting resin material.
- 10 10. The package of Claim 2 wherein the first layer and the second layer each comprise solder materials.
11. The package of Claim 10 wherein the semiconductor die is mounted to the packaging substrate using a plurality of solder bumps;  
15 wherein the packaging substrate includes a stiffener element that is mounted between the heat spreader and the substrate.
12. The package of Claim 2 wherein the first layer is formed of a solder material that has good adhesion to a material comprising a surface of the heat  
20 spreader; and  
wherein the second layer is formed of a solder material that has good adhesion to a material comprising a top surface of the die.
13. The package of Claim 2 wherein the core spacer element comprises a  
25 thermally non-conductive material and wherein the core spacer element includes a plurality of vias that penetrate through the core spacer element;  
wherein reflowable material of at least one of the first layer and the second layer fills at least a portion of the vias so that said first layer and the second layer are in physical contact with each other, thereby establishing thermal  
30 communication between the die and the heat spreader.

14. The package of Claim 2 wherein a backside of the packaging substrate has a plurality of solder balls configured for attaching and electrically connecting the package with a circuit board; and
- 5 wherein a reflow process is used to attach the heat spreader to the first layer, to attach the second layer to the die, and to attach the solder balls of the substrate to the circuit board.
15. A method for forming a semiconductor package, the method comprising:
- 10 providing a semiconductor substrate having a semiconductor die mounted thereon;
- providing a multilayer heat transfer element that includes a core portion with a top surface and a bottom surface wherein the top surface includes a first layer comprised of a thermally conductive reflowable material and wherein the bottom surface includes a second layer comprised of a thermally conductive
- 15 reflowable material;
- positioning the multilayer heat transfer element on the die; and
- positioning a heatspreader on the multilayer heat transfer element.
16. A method as in Claim 15 including the further operation of reflowing the package to adhere the thermally conductive reflowable material of the first layer
- 20 of the multilayer heat transfer element to the heatspreader and to adhere the thermally conductive reflowable material of the second layer of the multilayer thermal transfer heat conductor to the die.
17. A method as in Claim 16 further including:
- 25 providing a circuit board suitable for having mounting thereon, a semiconductor package;
- wherein providing a semiconductor substrate includes providing a semiconductor substrate having a plurality of solder balls mounted on a backside
- 30 of the semiconductor substrate; and
- wherein reflowing the package comprises reflowing the package to adhere the solder balls of the substrate to the circuit board.

18. A method as in Claim 17 wherein reflowing the package comprises reflowing the package to simultaneously:
- adhere the solder balls of the substrate to the circuit board,
  - 5 adhere the thermally conductive reflowable material of the first layer of the multilayer heat transfer element to the heat spreader, and
  - adhere the thermally conductive reflowable material of the second layer of the multilayer heat transfer element to the die.
- 10 19. A method as in Claim 16 further including the operation of applying a stiffener to the substrate.
20. A method as in Claim 18 wherein providing the multilayer heat transfer element includes providing a thermal transfer heat conductor having a thermally  
15 conductive core portion.
21. A method as in Claim 18 wherein providing the multilayer heat transfer element includes providing a multilayer heat transfer element having a thermally non-conductive core portion wherein the core includes openings therein to enable  
20 thermal communication between the first layer and the second layer.
22. A method for forming a multilayer heat transfer element that includes a core portion with a top surface and a bottom surface wherein the top surface includes a first layer comprised of a thermally conductive reflowable material and  
25 wherein the bottom surface includes a second layer comprised of a thermally conductive reflowable material, the method comprising:
- providing a plate of core material having a top surface and a bottom surface;
  - forming a first layer on the top surface of the core material, the first layer  
30 comprised of a thermally conductive reflowable material;
  - forming a second layer on the bottom surface of the core material, the second layer comprised of a thermally conductive reflowable material; and

singulating the plate into a plurality of multilayer heat transfer elements.

23. The method of Claim 22 wherein providing a plate of core material  
comprises providing a plate of core material having a plurality of depressions in at  
5 least one of the top surface and the bottom surface.

24. The method of Claim 22 wherein providing a plate of core material  
comprises providing a plate of core material having a plurality of openings that  
penetrate completely through the core.  
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25. The method of Claim 22 wherein providing a plate of core material  
comprises providing a core material comprising a thermally conductive material;  
wherein forming the first layer comprises forming the first layer with a  
solder material; and  
15 wherein forming the second layer comprises forming the second layer with  
a solder material.

26. The method of Claim 25 wherein providing a plate of core material  
comprises providing a plate of core material having a plurality of depressions in at  
20 least one of the top surface and the bottom surface.

27. The method of Claim 25 wherein providing a plate of core material  
comprises providing a plate of core material having a plurality of openings that  
penetrate completely through the core.  
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28. The method of Claim 22 wherein providing a plate of core material  
comprises providing a core material comprising a thermally non-conductive  
material having a plurality of openings that penetrate completely through the core;  
wherein forming the first layer comprises forming the first layer with a  
30 solder material;  
wherein forming the second layer comprises forming the second layer with  
a solder material.

wherein forming the first layer and second layer comprises forming at least one of the first layer and the second layer such that at least some of the openings in the core are filled with a solder material to establish physical contact between the first layer and the second layer and thereby establish thermal communication  
5 between the first layer and the second layer.